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Yield of Old-Field Slash Pine Plantations

by

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INTRODUCTION

There are 500,000 acres of planted slash pine in the Georgia middle coastal plain and the Carolina Sandhills, with the oldest plantations dating back 25 years or more to early Civilian Conservation Corps days. Although the present plantation acreage is substantial, it is expected to expand considerably in the near future. Georgia, for instance, produced about 200,000,000 slash pine seedlings in 1958, many of which were planted in the middle coastal plain area.

The management of existing plantations and the establishment of new plantations should be based upon the experience of the past 25 years. The Southeastern Forest Experiment Station, through the Cordele and Charleston Research Centers, has evaluated the wood yield potentials in relation to site productivity, age, spacing, survival, and degree of utilization.1/

THE STUDY AREA

The study covered 43 counties of the Georgia middle coastal plain and 14 in the Carolina Sandhills (fig. 1). The Georgia area is characterized by a level to rolling topography dissected by many intermittent streams. Topographic conditions of the Carolina Sandhills vary greatly, ranging from deep sand ridges to low bog areas. The major soils of both areas are sands and loamy sands of the Norfolk, Marlboro, and Lakeland groups. The soil series most frequently encountered were Norfolk, Lakeland, Kershaw, Tifton, and Gilead.

The plantations sampled were mostly in old fields. These fields generally represent the poorest agricultural land, but often are more fertile than the surrounding woodland sites.

1/ Cooperation of the South Carolina Commission of Forestry; Georgia Forestry Commission; North Carolina Department of Conservation and Development; Duke University School of Forestry; West Virginia Pulp and Paper Company; and Savannah River Project, Atomic Energy Commission is gratefully acknowledged. Cooperators' assistance in locating plots, in planning, and in monetary and professional aid made this project possible.

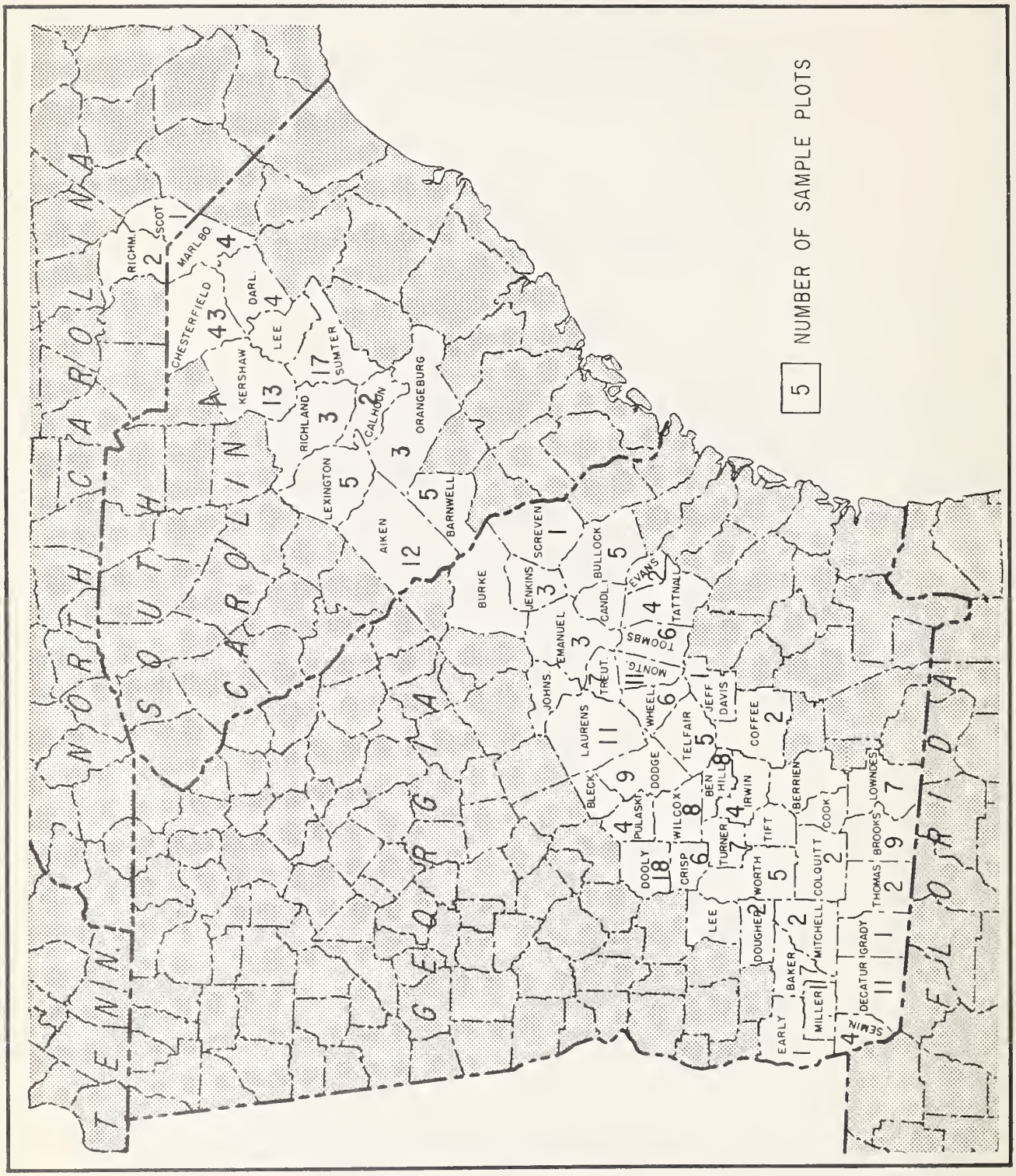

Figure 1.--Distribution of sample plots by counties.

STUDY METHODS

The study involved three phases: (1) The construction of volume tables from data collected on or near the sample plots; (2) the construction of site index curves suitable for calibrating sites on the basis of heights of dominant and codominant trees at 25 years of age; and (3) the establishment of wood yields in cubic feet in relation to age, site index, and stand density.

Field work for the yield study was completed in the summers of 1956 and 1957. The field crews also collected soils and wood-weight information that will be fully reported in separate publications. The soils data applicable to this study are presented in this publication.

VOLUME TABLE CONSTRUCTION

Five hundred and fifty-three trees were felled and measured for constructing volume tables. Cubic volumes, inside and outside bark, were determined for each tree to 4-inch, 3-inch, and 2-inch minimum top diameters outside bark. These data were then subjected to multiple regression analysis, and of the several relationships tested, the product of diameter at breast height squared times total height accounted for about 98 percent of the variation. The equations developed by this analysis appear below.

Top Diameter 4.0 Inches Outside Bark

Cubic foot volume (outside bark) = $0.002706\ D^2H - 1.045389$

Cubic foot volume (inside bark) = $0.002157\ D^2H - 1.093180$

Top Diameter 3.0 Inches Outside Bark

Cubic foot volume (outside bark) = $0.002668\ D^2H - 0.396148$

Cubic foot volume (inside bark) = $0.002135\ D^2H - 0.693239$

Top Diameter 2.0 Inches Outside Bark

Cubic foot volume (outside bark) = $0.002668\ D^2H - 0.128974$

Cubic foot volume (inside bark) = $0.002136\ D^2H - 0.497202$

D = diameter breast high (in inches)

H = total tree height (in feet)

Volumes calculated by these equations appear in tables 1 and 2 in the Appendix.

SITE INDEX CURVES

Site values used in evaluating yield in relation to site quality were developed from height and age data collected on each sample plot. For the construction of site index curves, average tree height was determined by measuring the heights of dominant or codominant trees. Using these data, with the reciprocal of age as the independent variable, the following height-age equation was derived by regression analysis:

$$\text{Logarithm of height} = -5.40638\left(\frac{1}{\text{Age}}\right) + 2.0258$$

The equation was then arranged in the following form to obtain site values based on age 25:

$$\text{Log site index} = \text{logarithm of height} - 5.40638\left(\frac{1}{25} - \frac{1}{\text{Age}}\right)$$

The curves in figure 2 were developed from this equation. They are based on an index age of 25 and must not be confused with 50-year index curves developed for natural slash pine stands.

To find the site index of a slash pine planting between the ages of 10 and 25 years, it is only necessary to determine the plantation age and the average height of the dominant and codominant trees and apply this information to the curves in figure 2. Table 3 shows the average height of the dominant stand to be expected on different sites at various ages.

SOIL SITE INDEX

The soil site index table may be used to determine site index for unplanted land (table 4). The use of the table requires measurements of the thickness of the A_1 (surface) horizon and the depth to a fine textured horizon. For areas in the Georgia middle coastal plain, section A of table 4 applies; in the Carolina Sandhills, section B should be used. These soil-site index tables are derived from related work by C. E. McGee and Clarke Row, summarized in unpublished masters theses at Duke University, 1957 and 1958 respectively.

CUBIC YIELDS

In order to establish the relationship of yield to age, site index, spacing, survival, and degree of utilization, 308 temporary sample plots were established (fig. 1). Plots were selected to obtain adequate geographic coverage. Their distribution in relation to age, spacing, and site is shown in tables 5, 6, and 7. A high percentage of plots fall within a narrow site range despite an effort to sample a full range of sites. Consequently, the authors feel there are few successful old-field plantations on areas with site indexes less than 50 feet at 25 years. Suitable plantations over 20 years of age were also limited in number because many had been thinned or worked for naval stores. Since both treatments affect growth and yield, plantations so affected could not be used.

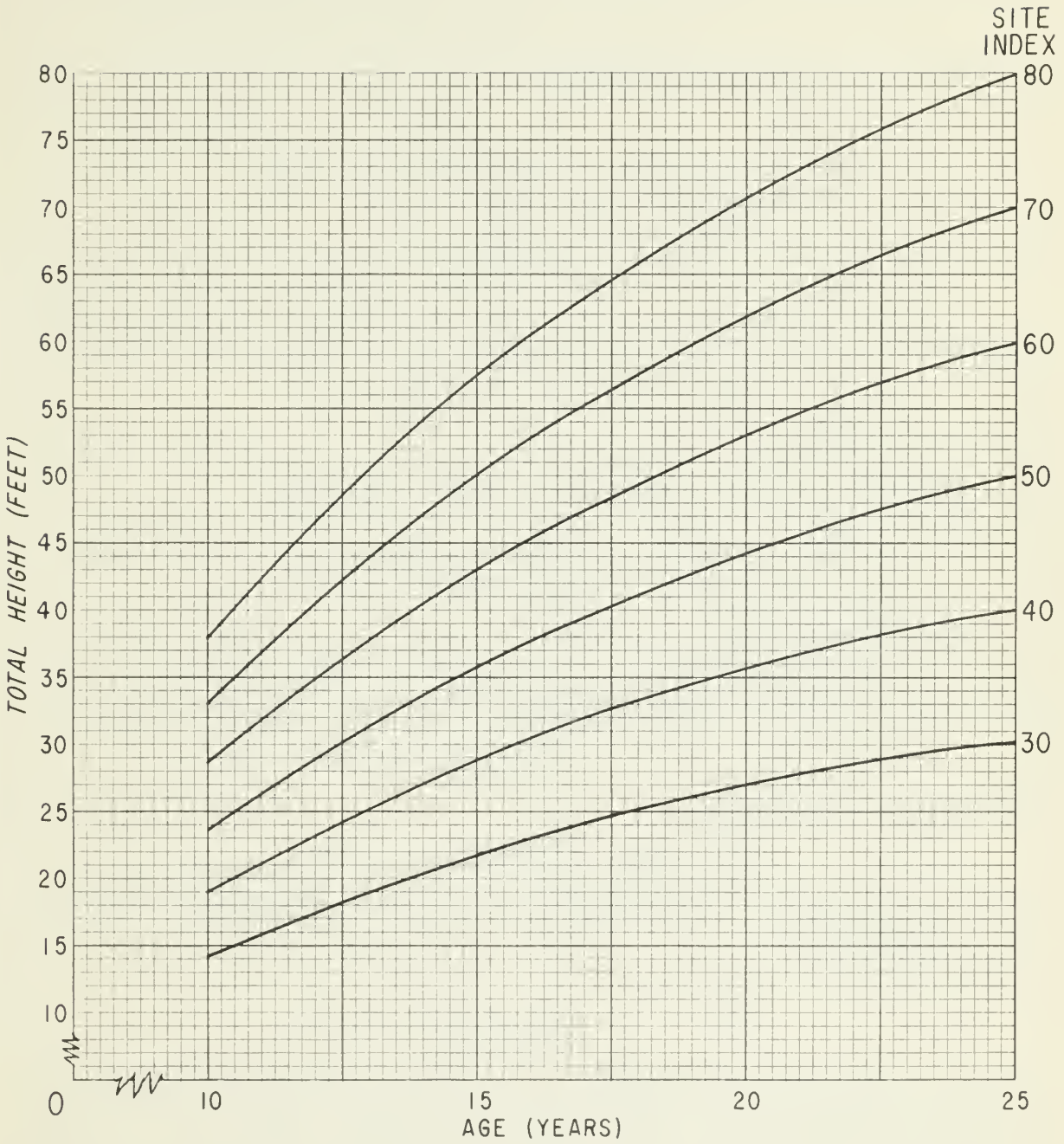

Figure 2.--Site curves at an index age of 25 years for old-field slash pine plantations of the middle coastal plain of Georgia and the Carolina Sandhills.

Selection of Yield Plots

Plantations were considered suitable for sampling when there were no recognizable factors affecting growth other than those being measured. Plantations included in the sampling had to meet the following specifications:

1. Be at least 9 years of age.
2. Show no evidence of thinning.
3. Be unburned.
4. Be unpruned.
5. Show no evidence of heavy disease or insect attack.
6. Have fair survival and good distribution.
7. Show no evidence of interplanting.
8. Be void, or nearly so, of wildlings.

To permit the measurement of approximately the same number of trees per plot, a variable plot size containing about 64 trees (living and dead) was used. The usual plot layout was 8 rows by 8 rows.

Plot Measurements

Separate records were made for each plot as follows:

1. Age of the plantation. Age was determined from increment borings at a height of 1 foot, or from cut trees.
2. Original spacing.
3. Plot dimensions.
4. A complete tree tally by 1-inch diameter classes.
5. On each plot the first and eighth trees (or the first and last, if there were not eight present) in each diameter class were also measured for total height in feet and d.b.h. to nearest tenth inch.

Plot Volume Determination

The first step in calculating plot volumes in cubic feet was the development of an equation for estimating heights by diameter classes on each plot. The height-diameter data were analyzed by regression methods and the following equation developed:

$$\text{Height} = b_o + b_1 D + b_2 D^2 + b_3 D^3$$

where D = diameter at breast height. The coefficients in this equation were determined for each plot. Heights by diameter classes on each plot were then calculated and the diameter-class volumes determined. Total plot volume was computed by multiplying each diameter-class volume by the number of trees in the particular diameter class. Plot volumes were then adjusted to an acre basis.

Statistical Analysis

Analysis of the cubic volume data was by conventional regression technique, which established the following variables as highly significant:

The reciprocal of plantation age.
Site index (height at age 25 of dominant stand).
The logarithm of effective space per tree (original space per tree divided by percent survival).
The reciprocal of site index.

These variables account for 86 percent of the variation about the mean.

A number of other variables and interactions were tested; because their inclusion did not improve the estimating equations, they were omitted.

The yield equations for different degrees of utilization are as follows:

Top Diameter 4.0 Inches Outside Bark

$$\text{Log of yield in cubic feet, outside bark} = 8.9538389 - 17.80865\left(\frac{1}{\text{Age}}\right) - 0.018488158\,(\text{Site Index}) - 0.44864\log\left(\frac{\text{Square feet per tree}}{\text{Survival (in percent)}}\right) - 155.47183\left(\frac{1}{\text{Site Index}}\right)$$

$$\text{Log of yield in cubic feet, inside bark} = 9.2796891 - 20.63365\left(\frac{1}{\text{Age}}\right) - 0.019481521\,(\text{Site Index}) - 0.42716\log\left(\frac{\text{Square feet per tree}}{\text{Survival (in percent)}}\right) - 172.25284\left(\frac{1}{\text{Site Index}}\right)$$

Top Diameter 3.0 Inches Outside Bark

$$\text{Log of yield in cubic feet, outside bark} = 8.4847192 - 14.79800\left(\frac{1}{\text{Age}}\right) - 0.016958973\,(\text{Site Index}) - 0.48084\log\left(\frac{\text{Square feet per tree}}{\text{Survival (in percent)}}\right) - 136.32887\left(\frac{1}{\text{Site Index}}\right)$$

$$\text{Log of yield in cubic feet, inside bark} = 8.6636675 - 16.83688\left(\frac{1}{\text{Age}}\right) - 0.017773496\,(\text{Site Index}) - 0.45630\log\left(\frac{\text{Square feet per tree}}{\text{Survival (in percent)}}\right) - 148.29603\left(\frac{1}{\text{Site Index}}\right)$$

Top Diameter 2.0 Inches Outside Bark

$$\text{Log of yield in cubic feet, outside bark} = 8.5148781 - 13.96498\left(\frac{1}{\text{Age}}\right) - 0.017656104\,(\text{Site Index}) - 0.494811 \log\left(\frac{\text{Square feet per tree}}{\text{Survival (in percent)}}\right) - 135.53031\left(\frac{1}{\text{Site Index}}\right)$$

$$\text{Log of yield in cubic feet, inside bark} = 8.66324265 - 15.67807\left(\frac{1}{\text{Age}}\right) - 0.018599315\,(\text{Site Index}) - 0.46887 \log\left(\frac{\text{Square feet per tree}}{\text{Survival (in percent)}}\right) - 146.42897\left(\frac{1}{\text{Site Index}}\right)$$

Tables 8 to 13 present volume yields calculated by means of these equations for the various age, site, and stand density categories. The survival percentages used in computing these tables are given in table 14.

Use of the Yield Tables

The yield tables provide an estimate of the potential wood production capacity for plantations under varying conditions of site, age, spacing, and top utilization limits. When the tables are used to estimate the actual yield obtainable from plantations where mortality occurs in clusters, some adjustment of the tabular yields may be required. Such adjustments are necessitated because the sample plots contained no openings or voids of measurable size. Trees often tend to die in groups, however, leaving openings or voids of measurable size within the plantation. To arrive at a reasonable yield estimate, these voids must be accounted for in the total plantation acreage.

Small openings involving a single row or groups of four trees or less could be ignored, but in larger groups the vacant space should be subtracted from the plantation acreage. If recent aerial photographs are available, the opening can be mapped out. If the area must be computed from ground measurements, the dimension of the opening should be measured from the crown edges instead of from the trunks. This would not only match the area as measured on photographs, but would also allow for the growth response of the trees on the periphery of the opening.

For use in plantations with random mortality differing appreciably from that on which the tables are based, some adjustment in the calculated yields will be necessary. A 3-percent adjustment should be made in the tabular yield for each 5-point (5 percent) variation in survival from that on which the calculated yield is based. This applies to all the yield tables.

To illustrate this adjustment, consider a 15-year-old 6 x 6 planting in which mortality is well distributed throughout the stand and survival is 50 percent. Table 14 indicates that the tabled yield estimates for 15-year-old plantations spaced 6 x 6 were prepared using 70 percent survival. The percentage adjustment is then calculated as follows:

$$\frac{50\% - 70\%}{5\%} \times 3\% = -12\%$$

In this case, the tabular yields would be decreased 12% to account for mortality.

The yield table values are in cubic feet. For cordwood estimates a converting factor of 92 cubic feet of wood and bark per standard cord of 128 cubic feet may be used. This is based on supplemental measurements at two pulpmills as the wood arrived by railway car. If estimates by weight are desired, a conversion factor of 55 pounds per cubic foot is recommended. This factor is the ratio of the weight of wood plus bark to outside bark cubic foot volume.

The effect of age, site, and stand density on diameter growth is illustrated in table 15. These values were established by regression analysis, and the final estimating equation reads as follows:

Logarithm of d.b.h. = 0.650712 + 0.000219 (Age x Site Index)

- 0.234544 (Logarithm Number of Trees Per Acre)

+ 0.314215 (Logarithm Site Index)

These variables account for 93.5 percent of the variation.

APPENDIX

Tables 1 and 2--Cubic foot volume tables.

Table 3--Height of dominant stand by age and site index (age 25).

Table 4--Soil site index (age 25).

Table 5--Distribution of sample plots by age and site index (age 25).

Table 6--Distribution of sample plots by age and spacing.

Table 7--Distribution of sample plots by site index (age 25) and spacing.

Tables 8 through 13--Yields of slash pine plantations.

Table 14--Survival by age and stand density.

Table 15--Average diameter at breast height.

Table 1. --Cubic foot volumes (outside bark) for slash pine plantations

TOP DIAMETER 4.0 INCHES OUTSIDE BARK

D.b.h. (Inches)	Total tree height in feet--											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	.31	.65	.98	1.32	1.66	2.00	2.34	2.68	3.01			
6	.90	1.39	1.88	2.36	2.85	3.34	3.83	4.31	4.80	5.29		
7		2.27	2.93	3.60	4.26	4.92	5.59	6.25	6.91	7.57	8.24	
8			4.15	5.02	5.88	6.75	7.61	8.48	9.35	10.21	11.08	11.94
9				6.63	7.72	8.82	9.91	11.01	12.11	13.20	14.30	15.39
10					9.78	11.13	12.48	13.84	15.19	16.54	17.89	19.25
11					12.05	13.69	15.33	16.96	18.60	20.24	21.87	23.51
12					14.54	16.48	18.44	20.39	22.33	24.28	26.23	28.18

TOP DIAMETER 3.0 INCHES OUTSIDE BARK

5	.93	1.27	1.60	1.94	2.27	2.60	2.94	3.27	3.60			
6	1.52	2.00	2.48	2.96	3.44	3.92	4.40	4.88	5.36	5.84		
7		2.87	3.53	4.18	4.83	5.49	6.14	6.79	7.45	8.10	8.76	
8			4.73	5.58	6.43	7.29	8.14	9.00	9.85	10.70	11.56	12.41
9				7.17	8.24	9.33	10.41	11.49	12.57	13.65	14.73	15.81
10					10.28	11.61	12.94	14.28	15.61	16.95	18.28	19.61
11					12.52	14.13	15.74	17.36	18.97	20.59	22.20	23.82
12					14.97	16.89	18.81	20.73	22.66	24.58	26.50	28.42

TOP DIAMETER 2.0 INCHES OUTSIDE BARK

5	1.20	1.53	1.87	2.20	2.54	2.87	3.21	3.54	3.87			
6	1.79	2.27	2.75	3.23	3.71	4.19	4.67	5.15	5.63	6.11		
7		3.14	3.79	4.44	5.10	5.75	6.40	7.06	7.71	8.37	9.02	
8			4.99	5.84	6.70	7.56	8.41	9.26	10.11	10.97	11.82	12.68
9				7.43	8.52	9.60	10.68	11.76	12.84	13.92	15.00	16.08
10					10.54	11.88	13.21	14.54	15.88	17.21	18.55	19.88
11					12.78	14.40	16.01	17.63	19.24	20.86	22.46	24.08
12					15.24	17.16	19.08	21.00	22.92	24.84	26.76	28.67

Table 2. --Cubic foot volumes (inside bark) for slash pine plantations

TOP DIAMETER 4.0 INCHES OUTSIDE BARK

D.b.h. (Inches)	Total tree height in feet--											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	--	.25	.52	.79	1.06	1.33	1.60	1.87	2.14			
6	.46	.85	1.24	1.62	2.01	2.40	2.79	3.18	3.57	3.95		
7		1.55	2.08	2.61	3.14	3.66	4.19	4.72	5.25	5.78	6.31	
8			3.05	3.74	4.43	5.12	5.81	6.50	7.19	7.88	8.57	9.26
9				5.02	5.89	6.77	7.64	8.52	9.39	10.26	11.14	12.01
10					7.54	8.61	9.69	10.77	11.85	12.93	14.01	15.08
11					9.35	10.65	11.96	13.26	14.57	15.87	17.18	18.48
12					11.33	12.88	14.44	15.99	17.54	19.10	20.65	22.20

TOP DIAMETER 3.0 INCHES OUTSIDE BARK

5	.37	.64	.91	1.18	1.44	1.71	1.98	2.24	2.51			
6	.90	1.28	1.67	2.05	2.43	2.82	3.20	3.59	3.97	4.36		
7		1.97	2.50	3.02	3.54	4.07	4.59	5.11	5.64	6.16	6.68	
8			3.41	4.09	4.77	5.46	6.14	6.82	7.50	8.19	8.87	9.56
9				5.36	6.22	7.09	7.95	8.82	9.68	10.55	11.41	12.28
10					7.85	8.91	9.98	11.05	12.12	13.18	14.25	15.32
11					9.64	10.93	12.22	13.52	14.81	16.09	17.39	18.68
12					11.60	13.14	14.68	16.22	17.75	19.30	20.83	22.38

TOP DIAMETER 2.0 INCHES OUTSIDE BARK

5	.57	.84	1.10	1.37	1.64	1.91	2.17	2.44	2.71			
6	1.04	1.43	1.81	2.19	2.58	2.96	3.35	3.73	4.12	4.50		
7		2.12	2.64	3.17	3.69	4.21	4.74	5.26	5.78	6.31	6.83	
8			3.60	4.29	4.97	5.65	6.34	7.02	7.70	8.39	9.07	9.76
9				5.56	6.42	7.29	8.15	9.02	9.88	10.75	11.61	12.48
10					8.05	9.12	10.18	11.25	12.32	13.39	14.46	15.52
11					9.84	11.13	12.42	13.72	15.01	16.30	17.59	18.89
12					11.81	13.34	14.88	16.42	17.96	19.49	21.03	22.57

Table 3. --Height of dominant stand by age and site index (age 25)

Age	Site index					
	30	40	50	60	70	80
	Feet					
10	14	19	24	28	33	38
11	16	21	26	31	37	42
12	18	23	29	35	40	46
13	19	25	31	38	44	50
14	20	27	34	40	47	54
15	22	29	36	43	50	57
16	23	30	38	45	52	61
17	24	32	40	47	55	63
18	25	33	41	49	57	66
19	26	34	43	51	60	68
20	27	35	44	53	62	70

Table 4. --Soil site index (age 25) for slash pine plantations on old fields of the Carolina Sandhills and the middle coastal plain of Georgia

Thickness of the A_1 horizon (inches)	Depth to fine textured horizon of--							
	10 inches	20 inches	30 inches	40 inches	50 inches	60 inches	80 inches	100 inches
	Feet							
1	46 / -	47 / -	47 / -	46 / -	45 / -	43 / -	- / -	- /
3	57 / 58	60 / 58	60 / 58	59 / 58	57 / 57	56 / 56	- / 55	- / 45
6	65 / 62	66 / 62	67 / 62	66 / 61	64 / 61	62 / 60	- / 58	- / 56
9	67 / 66	70 / 66	71 / 66	70 / 65	67 / 65	66 / 64	- / 62	- / 60
12	- /	74 / 70	74 / 70	73 / 69	72 / 69	69 / 68	- / 67	- / 64

KEY: A = Georgia middle coastal plain; B = Carolina Sandhills

Table 5. --Distribution of sample plots by age and site index (age 25)

Age class	Site index						
	30	40	50	60	70	80	Total
	Number						
10	-	2	2	27	12	2	45
13	-	2	5	22	27	3	59
16	2	1	4	49	47	6	109
19	-	1	10	31	36	1	79
22	-	2	1	9	-	-	12
25	-	-	1	1	1	-	3
28	-	-	-	-	1	-	1
Total	2	8	23	139	124	12	308

Table 6. --Distribution of sample plots by age and spacing

Spacing (feet)	Age (years)							
	10	13	16	19	22	25	28	Total
	Number							
4 x 2	-	1	-	-	-	-	-	1
4 x 4	-	-	-	1	-	-	-	1
4 x 5	-	-	-	-	1	-	-	1
5 x 5	-	1	1	-	1	-	-	3
5 x 6	1	2	4	4	3	-	-	14
6 x 6	3	6	9	12	2	-	-	32
6 x 7	3	11	8	11	1	-	-	34
6 x 8	7	2	5	10	-	1	-	25
5 x 10	1	1	1	-	-	-	-	3
7 x 8	3	4	12	-	-	1	-	20
6 x 10	2	3	4	2	-	1	-	12
8 x 8	5	5	21	3	1	-	-	35
6 x 12	2	1	6	3	-	-	-	12
8 x 10	4	4	12	2	-	-	-	22
8 x 12	3	2	2	1	-	-	-	8
10 x 10	3	3	7	8	1	-	-	22
10 x 12	4	3	4	2	1	-	1	15
7 x 20	-	-	1	-	-	-	-	1
12 x 12	1	2	3	5	1	-	-	12
12 x 15	1	1	1	2	-	-	-	5
14 x 14	2	1	2	2	-	-	-	7
10 x 20	-	2	2	2	-	-	-	6
15 x 15	-	2	1	1	-	-	-	4
12 x 20	-	1	1	-	-	-	-	2
16 x 16	-	-	1	4	-	-	-	5
17 x 17	-	-	1	3	-	-	-	4
18 x 20	-	-	-	1	-	-	-	1
20 x 20	-	1	-	-	-	-	-	1
Total	45	59	109	79	12	3	1	308

Table 7. --Distribution of sample plots by site index (age 25) and spacing

Spacing (feet)	Site index						
	30	40	50	60	70	80	Total
	Number						
4 x 2	-	-	1	-	-	-	1
4 x 4	-	-	-	1	-	-	1
4 x 5	-	-	-	1	-	-	1
5 x 5	-	-	-	3	-	-	3
5 x 6	-	-	3	6	5	-	14
6 x 6	-	-	5	17	10	-	32
6 x 7	-	-	4	20	9	1	34
6 x 8	-	2	2	11	9	1	25
5 x 10	-	-	-	1	2	-	3
7 x 8	1	-	-	9	9	1	20
6 x 10	-	-	3	4	5	-	12
8 x 8	1	-	3	12	18	1	35
6 x 12	-	-	-	6	6	-	12
8 x 10	-	2	-	8	12	-	22
8 x 12	-	1	1	4	-	2	8
10 x 10	-	2	1	9	9	1	22
10 x 12	-	-	-	7	7	1	15
7 x 20	-	-	-	1	-	-	1
12 x 12	-	-	-	5	6	1	12
12 x 15	-	-	-	3	2	-	5
14 x 14	-	-	-	3	3	1	7
10 x 20	-	-	-	2	3	1	6
15 x 15	-	-	-	2	2	-	4
12 x 20	-	-	-	1	1	-	2
16 x 16	-	-	-	2	3	-	5
17 x 17	-	-	-	1	2	1	4
18 x 20	-	-	-	-	1	-	1
20 x 20	-	1	-	-	-	-	1
Total	2	8	23	139	124	12	308

Table 8. --Yields (outside bark) of slash pine plantations of the middle coastal plain of Georgia and the Carolina Sandhills 1/

Age (years)	Original spacing	Site index (age 25)							
		40	45	50	55	60	65	70	75
	Feet	Cubic feet per acre							
10	6 x 6	61	135	240	369	511	657	788	912
	6 x 7	57	126	225	346	478	616	738	852
	6 x 8	54	119	212	327	451	582	697	809
	8 x 8	48	106	188	289	400	515	617	712
	8 x 10	44	96	171	263	365	469	562	648
	10 x 10	40	88	156	241	333	428	514	593
	15 x 15	29	65	115	177	244	315	377	435
15	6 x 6	237	522	926	1426	1972	2539	3042	3526
	6 x 7	222	488	868	1336	1847	2378	2849	3303
	6 x 8	209	461	819	1262	1745	2246	2691	3120
	8 x 8	186	409	726	1118	1546	1989	2384	2761
	8 x 10	169	372	662	1019	1409	1814	2174	2518
	10 x 10	155	340	605	931	1287	1657	1986	2303
	15 x 15	114	250	443	684	946	1218	1459	1699
20	6 x 6	463	1020	1812	2790	3858	4967	5952	6800
	6 x 7	434	955	1697	2612	3612	4650	5571	6388
	6 x 8	410	902	1603	2468	3412	4393	5230	5990
	8 x 8	363	799	1419	2185	3022	3891	4595	5260
	8 x 10	331	729	1295	1994	2757	3550	4190	4775
	10 x 10	302	666	1183	1822	2519	3210	3800	4315
	15 x 15	222	490	871	1341	1834	2310	2790	3275

1/ Includes all trees 4.6 inches in diameter and larger to a top diameter 4.0 inches outside bark.

Table 9. --Yields (inside bark) of slash pine plantations of the middle coastal plain of Georgia and the Carolina Sandhills 1/

Age (years)	Original spacing	Site index (age 25)							
		40	45	50	55	60	65	70	75
	Feet	Cubic feet per acre							
10	6 x 6	25	62	118	193	280	376	464	552
	6 x 7	24	58	111	182	263	353	436	518
	6 x 8	23	55	106	172	250	334	413	493
	8 x 8	20	49	94	153	222	297	368	437
	8 x 10	19	45	86	141	204	272	337	399
	10 x 10	17	41	79	129	187	250	310	367
	15 x 15	13	31	59	96	139	186	231	298
15	6 x 6	122	297	570	930	1346	1802	2228	2655
	6 x 7	115	280	535	873	1265	1693	2092	2514
	6 x 8	109	265	507	830	1197	1603	1981	2382
	8 x 8	97	236	451	737	1068	1428	1766	2120
	8 x 10	89	216	414	675	978	1308	1687	1942
	10 x 10	82	198	380	619	897	1200	1484	1783
	15 x 15	61	148	283	462	669	895	1106	1330
20	6 x 6	268	650	1243	2028	2938	3931	4700	5460
	6 x 7	252	610	1167	1905	2759	3692	4490	5205
	6 x 8	238	578	1106	1804	2613	3487	4200	4900
	8 x 8	212	515	985	1607	2328	3091	3718	4328
	8 x 10	195	472	902	1473	2134	2810	3428	3910
	10 x 10	179	433	828	1351	1958	2587	3173	3683
	15 x 15	133	323	619	1009	1439	1897	2360	2775

1/ Includes all trees 4.6 inches in diameter and larger to a top diameter 4.0 inches inside bark.

Table 10. --Yields (outside bark) of slash pine plantations of the middle coastal plain of Georgia and the Carolina Sandhills [1/]

Age (years)	Original spacing	Site index (age 25)							
		40	45	50	55	60	65	70	75
	Feet	Cubic feet per acre							
10	6 x 6	127	252	414	599	789	976	1134	1291
	6 x 7	119	234	386	558	735	910	1056	1180
	6 x 8	112	221	363	525	692	856	994	1125
	8 x 8	98	194	318	460	607	751	872	981
	8 x 10	88	176	288	417	550	680	790	889
	10 x 10	81	159	262	379	499	617	727	824
	15 x 15	57	114	188	272	358	443	545	654
15	6 x 6	389	772	1267	1835	2417	2989	3473	3918
	6 x 7	363	720	1181	1710	2256	2786	3238	3653
	6 x 8	342	677	1111	1608	2119	2621	3045	3436
	8 x 8	300	595	975	1413	1860	2302	2675	3014
	8 x 10	272	539	883	1279	1685	2085	2422	2731
	10 x 10	247	489	802	1161	1529	1892	2199	2480
	15 x 15	177	351	577	835	1099	1360	1580	1787
20	6 x 6	679	1344	2206	3193	4206	5204	6046	6905
	6 x 7	632	1252	2055	2975	3919	4848	5680	6512
	6 x 8	595	1178	1934	2799	3687	4532	5300	6120
	8 x 8	522	1035	1698	2458	3238	4005	4654	5300
	8 x 10	473	938	1539	2228	2934	3630	4218	4830
	10 x 10	430	851	1397	2022	2664	3296	3886	4410
	15 x 15	309	613	1006	1456	1917	2387	2860	3369

1/ Includes all trees 4.6 inches in diameter and larger to a top diameter 3.0 inches outside bark.

Table 11. --Yields (inside bark) of slash pine plantations of the middle coastal plain of Georgia and the Carolina Sandhills [1/]

Age (years)	Original spacing	Site index (age 25)							
		40	45	50	55	60	65	70	75
	Feet	Cubic feet per acre							
10	6 x 6	62	130	225	340	462	587	696	800
	6 x 7	58	122	210	318	432	549	651	747
	6 x 8	54	115	199	300	408	518	615	708
	8 x 8	48	102	176	265	360	458	543	622
	8 x 10	44	93	160	241	328	417	495	565
	10 x 10	40	85	146	220	299	380	451	516
	15 x 15	29	62	107	160	218	277	350	414
15	6 x 6	220	468	808	1218	1657	2104	2497	2870
	6 x 7	207	438	756	1139	1550	1969	2336	2685
	6 x 8	195	413	714	1075	1462	1857	2204	2533
	8 x 8	172	365	631	950	1293	1642	1949	2237
	8 x 10	157	332	574	865	1177	1495	1774	2037
	10 x 10	143	303	524	789	1074	1363	1618	1859
	15 x 15	105	221	383	576	785	997	1183	1372
20	6 x 6	416	881	1523	2295	3121	3965	4750	5510
	6 x 7	389	824	1424	2146	2919	3707	4520	5235
	6 x 8	367	778	1344	2025	2755	3510	4225	4950
	8 x 8	324	687	1188	1790	2435	3093	3760	4393
	8 x 10	296	627	1082	1630	2218	2845	3450	3995
	10 x 10	270	571	987	1488	2023	2620	3239	3750
	15 x 15	197	418	722	1089	1481	1956	2418	2890

1/ Includes all trees 4.6 inches in diameter and larger to a top diameter 3.0 inches inside bark.

Table 12. --Yields (outside bark) of slash pine plantations of the middle coastal plain of Georgia and the Carolina Sandhills [1/]

Age (years)	Original spacing	Site index (age 25)							
		40	45	50	55	60	65	70	75
	Feet	Cubic feet per acre							
10	6 x 6	153	300	487	697	908	1112	1279	1431
	6 x 7	143	279	453	648	845	1034	1190	1350
	6 x 8	134	262	426	609	793	971	1117	1263
	8 x 8	117	229	372	532	694	849	977	1088
	8 x 10	106	207	336	481	626	767	882	980
	10 x 10	96	187	304	435	567	694	798	889
	15 x 15	68	133	216	309	403	493	600	700
15	6 x 6	441	863	1399	2002	2609	3195	3676	4103
	6 x 7	410	802	1301	1862	2427	2972	3419	3817
	6 x 8	386	753	1222	1748	2279	2790	3209	3585
	8 x 8	337	660	1069	1530	1994	2441	2809	3133
	8 x 10	304	595	965	1382	1801	2205	2536	2831
	10 x 10	276	539	874	1251	1630	1996	2296	2563
	15 x 15	196	384	622	890	1160	1420	1634	1829
20	6 x 6	744	1454	2357	3374	4397	5384	6212	7000
	6 x 7	692	1352	2192	3137	4088	5006	5835	6585
	6 x 8	650	1270	2059	2946	3840	4702	5500	6200
	8 x 8	568	1110	1801	2577	3359	4112	4780	5410
	8 x 10	513	1003	1627	2329	3035	3717	4340	4937
	10 x 10	465	908	1473	2108	2748	3387	3980	4512
	15 x 15	331	648	1050	1503	2000	2490	2980	3470

1/ Includes all trees 4.6 inches in diameter and larger to a top diameter 2.0 inches outside bark.

Table 13. --Yields (inside bark) of slash pine plantations of the middle coastal plain of Georgia and the Carolina Sandhills [1/]

Age (years)	Original spacing	Site index (age 25)							
		40	45	50	55	60	65	70	75
	Feet	Cubic feet per acre							
10	6 x 6	79	164	278	418	551	689	806	914
	6 x 7	74	153	259	384	514	644	753	851
	6 x 8	70	144	244	362	485	607	710	807
	8 x 8	61	127	215	319	427	534	624	706
	8 x 10	56	115	195	290	388	485	567	639
	10 x 10	51	105	178	263	352	441	515	582
	15 x 15	37	76	129	191	255	319	400	465
15	6 x 6	259	537	911	1349	1806	2260	2644	2997
	6 x 7	242	501	851	1260	1687	2111	2469	2799
	6 x 8	227	472	801	1186	1588	1988	2326	2637
	8 x 8	200	417	706	1046	1400	1752	2050	2320
	8 x 10	182	378	641	950	1271	1591	1861	2109
	10 x 10	166	344	583	864	1157	1447	1693	1918
	15 x 15	120	249	422	626	838	1049	1227	1391
20	6 x 6	466	968	1640	2430	3253	4072	4861	5611
	6 x 7	435	904	1531	2268	3037	3800	4580	5302
	6 x 8	410	851	1443	2138	2861	3581	4309	5000
	8 x 8	361	750	1271	1883	2520	3211	3850	4491
	8 x 10	328	681	1155	1710	2290	2866	3470	4055
	10 x 10	298	620	1051	1556	2084	2680	3297	3840
	15 x 15	217	450	763	1130	1546	2014	2489	2979

1/ Includes all trees 4.6 inches in diameter and larger to a top diameter 2.0 inches inside bark.

Table 14. --Survival by age and stand density

Spacing (feet)	Age (years)		
	10	15	20
	- - - Percent - - -		
6 x 6	73	70	68
6 x 7	74	71	69
6 x 8	74	72	70
8 x 8	75	73	71
8 x 10	76	74	72
10 x 10	78	76	74
15 x 15	88	86	84

Table 15. --Average diameter at breast height of entire stand by age, spacing, and site index (age 25)

Age (years)	Original spacing	Surviving trees per acre	Site index							
			40	45	50	55	60	65	70	75
	Feet	Number	- - - - - - - - - - - - Inches - - - - - - - - - - - -							
10	6 x 6	886	3.5	3.8	4.0	4.2	4.4	4.6	4.9	5.2
	6 x 8	672	3.8	4.0	4.3	4.5	4.7	4.9	5.2	5.5
	8 x 8	513	4.0	4.3	4.5	4.8	5.1	5.2	5.6	5.9
	10 x 10	341	4.4	4.7	5.0	5.3	5.6	5.7	6.2	6.5
	12 x 12	249	4.8	5.1	5.4	5.7	6.0	6.2	6.6	7.0
	15 x 15	171	5.2	5.6	5.9	6.2	6.6	6.7	7.2	7.6
15	6 x 6	858	4.0	4.3	4.6	4.9	5.2	5.6	5.9	6.3
	6 x 8	651	4.2	4.6	4.9	5.2	5.6	5.9	6.3	6.7
	8 x 8	497	4.5	4.9	5.2	5.6	5.9	6.3	6.7	7.1
	10 x 10	331	5.0	5.3	5.7	6.0	6.5	7.0	7.4	7.9
	12 x 12	243	5.3	5.7	6.2	6.6	7.0	7.5	8.0	8.4
	15 x 15	167	5.8	6.3	6.7	7.2	7.7	8.2	8.7	9.2
20	6 x 6	830	4.4	4.8	5.2	5.7	6.1	6.6	7.1	7.7
	6 x 8	631	4.7	5.1	5.6	6.1	6.5	7.1	7.6	8.2
	8 x 8	482	5.0	5.5	6.0	6.4	7.0	7.5	8.1	8.7
	10 x 10	322	5.5	6.0	6.5	7.1	7.7	8.3	8.9	9.5
	12 x 12	236	5.9	6.5	7.0	7.6	8.2	8.9	9.6	10.3
	15 x 15	162	6.5	7.1	7.7	8.3	9.0	9.7	10.4	11.2

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